February 13, 1890.

Sir G. GABRIEL STOKES, Bart., President, in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

The following Papers were read:—

I. "The Liquation of Gold and Platinum Alloys." By EDWARD MATTHEY, F.S.A., F.C.S., Associate Royal School of Mines. Communicated by the President. Received January 17, 1890.

It is a well known fact that when molten alloys of certain metals are cooled, some of the constituents separate and become concentrated either in the centre or in the external portions of the solidified mass; to this segregation the name of liquation is given. It is specially noticeable in the case of silver-copper alloys, and its importance is now being widely recognised in almost all branches of metallurgy.

In the case of gold, however, the phenomenon of liquation does not appear to have been much observed. Gold alloys, to the value of many millions sterling, pass annually from hand to hand upon the results of assays cut from the external portions of ingots, which assays cannot, of course, be trustworthy, if the centre of the bars differs in composition from the external portions. Peligot has recently endeavoured to obtain evidence of liquation in gold-copper alloys, and has concluded that it does not exist.* Roberts-Austen,† who has devoted much time to the study of liquation, has also satisfied himself that gold-silver alloys do not rearrange themselves on cooling.‡

It is, of course, well known that gold does not retain on solidifying certain metals of the platinum group; for instance, iridium, when associated with it, always tends to fall through the fluid metal, and is found at the bottom of the solidified mass, but this is probably not a case of true rejection of a metal by liquation, but is due to the higher specific gravity of the iridium, coupled with the fact that the usual heat at which gold is melted is not sufficiently high to bring

* 'Bulletin Société d'Encouragement,' 1889, p. 481.
† 'Roy. Soc. Proc.,' vol. 23, 1874, p. 481.
‡ 'Nineteenth Annual Report of the Mint,' 1888, p. 35.

about a true alloy. It appeared to me that alloys of gold and platinum would well repay examination. They have been generally considered to be uniform in composition, but certain results which I obtained in the course of their treatment led me to suspect that they would give interesting results, and the following experiments were therefore undertaken.

The metal platinum frequently occurs in the gold and silver bullion which has to be treated by the ordinary methods of refining, and its presence occasions no small amount of trouble to the refiner.

It is well known that there are two methods of refining, both of which involve alloying one part of gold with (about) three parts by weight of silver, and treating the mass directly—

(*a.*) With nitric acid,
(*b.*) With sulphuric acid.

The final result from either method, if properly conducted, is fine gold and fine silver—that is to say, if the alloy so treated is composed of gold and silver only (a little copper present making no difference).

In the case of platinum being present in the gold or the silver, if it is refined by the nitric acid process, the platinum, when existing in small proportions, is eliminated with the silver, becoming dissolved up with it, leaving the gold free, and the platinum so dissolved can afterwards be readily separated from the silver, but upon the large scale refining by means of nitric acid is far too costly; practically, therefore, this has to be replaced by the sulphuric acid process.

In an alloy of gold and silver, containing a small proportion of platinum, nearly all the silver is dissolved by the sulphuric acid, leaving the platinum associated with the gold.

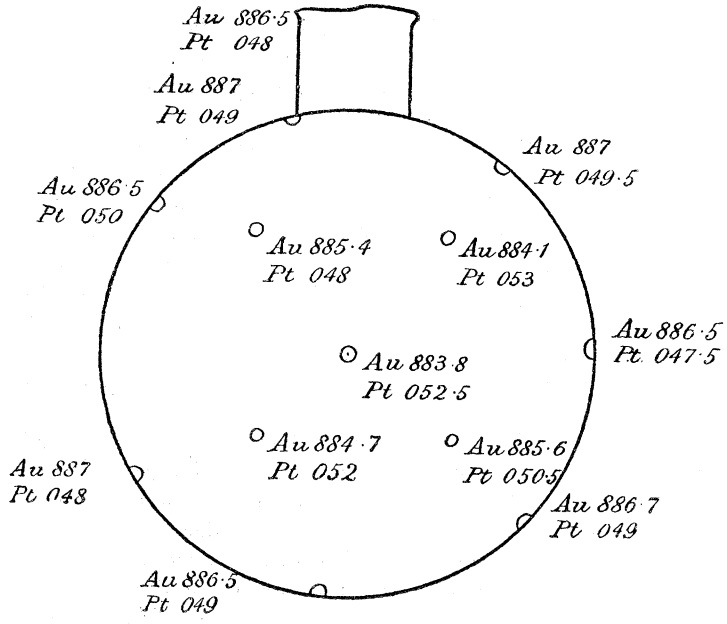
In order to simplify matters for further treatment, this partially refined gold holding the platinum is melted and assayed, to determine the amount of platinum and gold it contains; it is the platinum-gold alloys so obtained that I desire to bring under notice.

It has been found in practice that the ordinary method of assaying a small portion cut from one end of a bar or ingot of such metal does *not* indicate the actual percentage of gold and of platinum existing in the entire mass, and it is therefore evident that the platinum has been redistributed by liquation during the cooling and solidification of the mass.

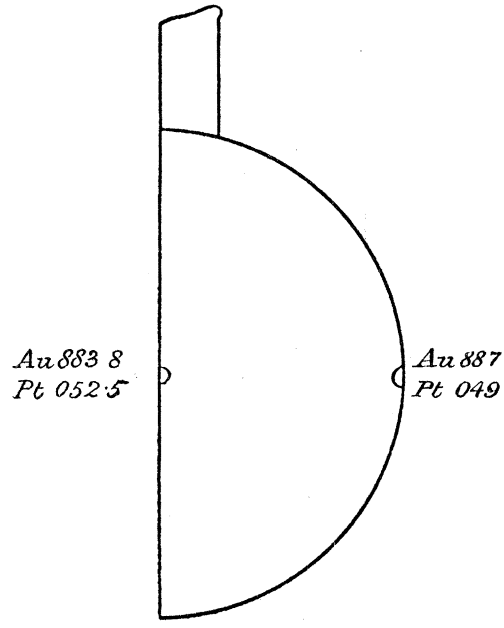
Having been struck by the experiments made by Professor Roberts-Austen, as detailed in the paper to which reference has already been made, I cast some gold containing platinum into a special iron mould 3 inches in diameter, and cut the spheres of metal so obtained in two halves. I may mention that I had to cast these spheres many times over in order to obtain a solid casting, so great was the shrinkage.

Portions were then carefully taken from each of the points marked on the diagrams A, B, and C given herewith, and the results of the assays of the metal taken at each point of the hemispheres are indicated on the diagrams.

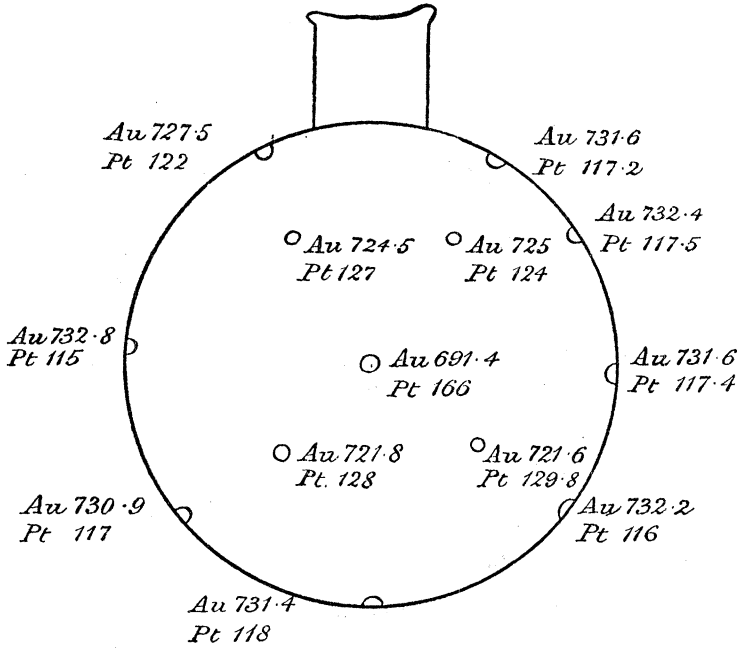
A.



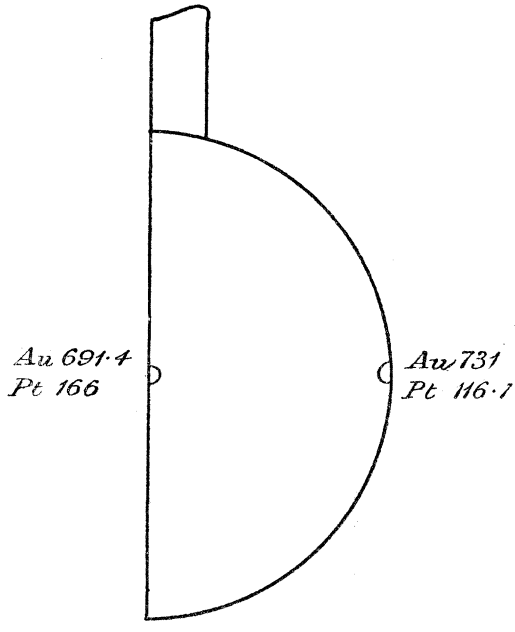
A.


Au 883 8
Pt 052·5
Au 887
Pt 049

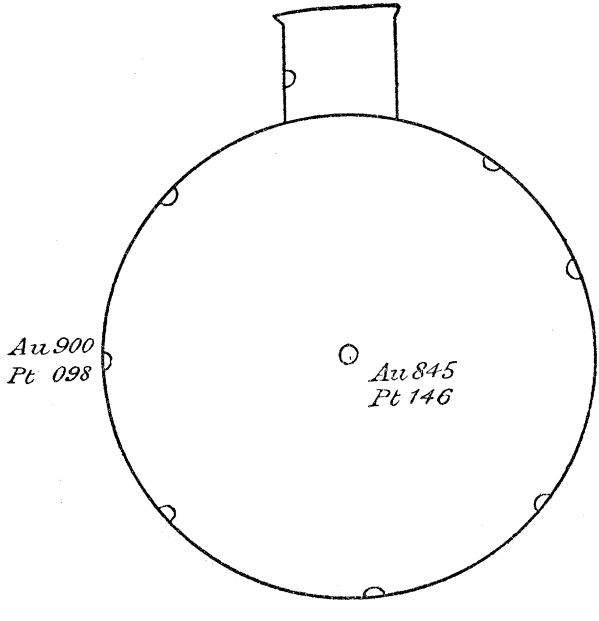
B.


Au 727·5
Pt 122
Au 731·6
Pt 117·2
Au 732·4
Pt 117·5
Au 724·5
Pt 127
Au 725
Pt 124
Au 732·8
Pt 115
Au 691·4
Pt 166
Au 731·6
Pt 117·4
Au 721·8
Pt. 128
Au 721·6
Pt 129·8
Au 730·9
Pt 117
Au 732·2
Pt 116
Au 731·4
Pt 118

B.



C.



A. Composed of about 880 gold to 050 platina.

B. Composed of about 700 gold to 120 platina.

In the one case the maximum difference between the gold percentage is a variation of 032, viz., 887 on the outside against 883·8 at the centre of the alloy, and in the platinum 047·5 on the outside against 052·5 at the centre, an extreme variation of 005 is shown.

In the other case the maximum difference between the gold percentage is a variation of 041, viz., 732·4 on the outside, against 694·1 at the centre of the alloy, and in the platinum 122 on the outside against 166 at the centre, an extreme variation of 044.

Thus showing indisputably that *the platinum in cooling liquates from the gold and becomes concentrated towards the centre of the alloy.*

In support of these experimental results I give the actual figures obtained from six platinum-gold ingots, taken at different times and of different qualities, as they occurred in the course of refining commercially. Each of these bars, after melting and assaying, was separately heated with a view to extract the amount of gold contained. It will be at once seen that the higher percentage of gold indicated by the assay of a portion cut from one end of the ingot is *not* borne out by the actual amount of fine gold obtained by refining, which, of course, truly represents the proportion of gold existing in each bar.

Number.	Weight in troy ounces.	Platinum by assay.	Gold by assay.	Percentage of gold by the fine gold actually obtained.
42	728·5	0·111	0·825	0·812
67	355·0	0·120	0·660	0·630
109	589·5	0·120	0·800	0·780
126	435·0	0·045	0·850	0·845
149	480·5	0·086	0·842	0·830
188	473·0	0·110	0·830	0·821

These results prove that the percentage of gold in the outer portion of ingots of platinum-gold alloy does not represent the true percentage of gold in the alloy, and that liquation *does take place* to an extent which, independently of its scientific and metallurgical interest, has, I believe, been by many overlooked up to the present time in commercial transactions with such metal.

The results given were observed in platinum-gold alloyed with silver, with copper, and with both silver and copper; but, in order to prove whether or not such alloy had any tendency to carry the

platinum to the centre of the mass, I melted 900 parts of fine gold with 100 parts of pure platinum, and, after repeated meltings, cast this alloy into the same mould used for the experiments recorded above. The result was, as in the previous cases, liquation of the platinum towards the centre of the sphere, the gold and platinum in 1000 parts being as 900 to 098 on the exterior, against 845 and 146 at the centre of the mass (see diagram C).

II. "On the Unit of Length of a Standard Scale by Sir George Shuckburgh, appertaining to the Royal Society." By General J. T. WALKER, R.E., F.R.S. Received February 3, 1890.

In the determinations of the length of the seconds pendulum, which were made in London by Kater and at Greenwich by Sabine, and are described in the 'Philosophical Transactions' for 1818, 1829, and 1831, the distance between the upper and lower edges of the pendulum was measured off on a standard scale which had been constructed by Sir George Shuckburgh. The scale had not been compared with any of the modern standard scales, but it had been preserved with much care with the instruments appertaining to the Royal Society.

In the autumn of 1888, M. le Commandant Defforges, an officer of the French Geodetic Survey, came to England to take a share in operations for the determination of the difference in longitude between Greenwich and Paris, and also to determine the length of a French seconds pendulum at Greenwich. He kindly undertook to comply with a suggestion which was made to him by me, to compare the portion of Shuckburgh's scale which had been employed by Kater and Sabine with one of the standard metre bars of the International Bureau of Weights and Measures in Paris. The Council of the Royal Society assented, and the scale was sent across to Paris and brought back again by special messenger.

The details and results of the comparison are given in the following account by Commandant Defforges, from which it will be seen that the scale was compared with the French metrical brass scale, N, at the temperature of 48·7° F., at which the distance between Kater and Sabine's divisions, 0 and 39·4, of the Shuckburgh scale was found equal to 1·0006245 metre. On reducing to the temperature of 62° F., which was employed by Kater and Sabine, this distance becomes 1·0007619 metre, which is equivalent to 39·400428 inches if we adopt the relation 1 metre = 39·370432 inches, which was determined by Colonel Clarke, C.B., of the Ordnance Survey, and is given in his valuable work on the Comparisons of Standards of Length. Thus